Remarks:

Claims 1-29 are in this case. All claims have been rejected. Claim 10 is rejected under 35 U.S.C. §112 and claims 1 - 23 are rejected under 35 U.S.C. §102 (b) as anticipated by Verdeill. Claims 24 - 29 are new. New claims 24 - 29 are method claims addressed to the deliberate emission of two or more co-existing modes as disclosed at pages 2, line 23 through page 3, line 7 and elsewhere throughout the detailed description of the Specification. No new matter is added.

REJECTION UNDER 35 U.S.C. §112:

Claim 10 is rejected under 35 U.S.C. §112 as indefinite. The Examiner alleges that it is unclear how the gain medium and the optical waveguide are coupled in the "absence of coupling optics". This rejection is respectfully traversed.

As to lexicography, the settled rule has been for some time that applicants may define words, terms, and phrases, and that sufficient disclosure is made if the word or phrase is adequately explained, defined, or made inherently clear as to its meaning. "It is well established that when a general term is used to introduce a concept that is further defined more narrowly, the general term must be understood in the context in which the inventor presents it". (In re Frank S. Glaug, 283 F.3d 1335 (Fed.cir.2002)).

In the prior art a fiber was optically coupled to a device by coupling optics. (Specification, page 2, lines 2-4). These coupling techniques included tapered or conical lenses formed or spliced onto the fiber, or a variety of other lens configurations. (Specification, page 2, lines 4-6). Such optical coupling

arrangements are complex and require precise alignment. (Specification, page 2, lines 7-8).

Webster's dictionary defines optics as "any of the elements (as lenses, mirrors, or light guides) of an optical instrument or system -- usually used in plural". (Merriam-Webster online dictionary, <http://www.webster.com>). Coupling is defined as linking together. Applicants define a lack of coupling optics, as the absence of a requirement for complex and precise coupling optics, such as when an optical fiber is simply secured in a v-groove adjacent to a gain media. (Specification, page 3, lines 15-17). This definition is consistent with the plain meaning of the phrase.

Moreover on page 5 of the specification, applicants state, "it is possible to avoid the use of coupling optics, e.g. the beam can simply be directed into the polished end of the waveguide, and yet attain high coupling efficiencies, typically at least 40%, advantageously at least 50%. For example, it is possible to simply place or glue an optical fiber into a v-groove adjacent the gain media. (Specification, page 5, lines 24-27).

The Examiner appears to make a philosophical argument that any optical coupling, by definition, requires coupling optics. This is not how the inventors use the term. The applicants have clearly and consistently defined the terms "coupling optics" and "lack of coupling optics". The Examiner's understanding of the term "coupling optics" is inconsistent with the inventor's presentation. Therefore, this rejection is believed to be incorrect and is respectfully traversed.

REJECTION UNDER 35 U.S.C. §102(b):

Claims 1-23 are rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 5,870,417, "*Thermal Compensators for DBR Laser Sources*", issued February 9, 1999 to Verdiell, et al. (hereinafter "Verdiell").

These rejections are respectfully traversed.

It is well established that a claimed invention is anticipated by a prior patent only if the patent discloses each and every limitation of the claim. In the present case, claims 1-23 are directed to an optical communication system comprising an external cavity laser wherein the laser is configured to provide multimode output of at least two modes within the grating bandwidth. As previously argued in this reply, Verdiell does not disclose a multimode output comprising two or more co-existing modes, as contemplated by the inventors.

In this reply applicants provide helpful background information to further explain the distinction between the instant invention and Verdiell and to clarify that Verdiell does not disclose the limitations of the instant claims. Also, in this reply, Dr. Manyalibo Matthews, a recognized expert in the art of fiber grating lasers and optical communications, offers an affidavit under 37 C.F.R. §1.132 in support of applicant's arguments. Dr. Matthews is employed by the assignee of the instant invention.

Communication lasers have been optimized for a single line (wavelength) output. In fact, in communications systems, great effort has been made to design communications lasers that lase in only a single narrow line.

External fiber grating lasers employing a grating (typically a Bragg grating) can be used in communications applications. The grating sets the lasing wavelength of the laser. A very slight change in the grating environment, such as a temperature shift, can cause the grating wavelength to change.

The laser can follow the grating wavelength to a point, but then there is a discontinuity in the wavelength of the lasing. The discontinuity occurs because the laser shifts to the nearest dominant mode that is supported by the new grating wavelength. In some configurations, single line emission is held to a fixed wavelength by tuning the grating, as by temperature control to compensate for any adverse changes in grating wavelength, such as those caused by changes in ambient temperature.

On Mode Hopping vs. Co-Existing modes (multimode emission):

Modes of light are solutions to the wave equations that define a given optical path's available modes of propagation. A shift in grating wavelength causes an operating communication laser to shift in wavelength towards a nearby available propagation mode. During this shift, the laser light slews in wavelength while maintaining propagation in the first dominant mode.

When the change in grating wavelength causes the propagation mode of the laser to be close to the next dominant mode, a discontinuity quickly transitions the laser to the next dominant mode and the wavelength of the laser emission returns to a wavelength near the wavelength at the beginning of the process. These wavelength "ramps" repeat in wavelength in a sawtooth curve fashion because of the free spectral range of the grating. The free spectral range of an optical filter repeats a characteristic response curve with some regular period (the FSR).

Verdiell explains the process of mode hopping. The Examiner's attention is directed to Verdiell, fig. 9. Here, Verdiell presents a graph of laser wavelength versus temperature. As the temperature increases, the single line emission (single mode) of Verdiell's laser slews in wavelength (λ) while maintaining a particular dominant mode. 96, for example, shows operation in a first mode at a temperature indicated by the first dotted line. At 94, the second temperature and dotted line, the first dominant mode is still present as a single line emission at a higher wavelength. 95 shows a continued temperature change and a continued shift in λ, but lasing still in the first dominant mode.

At the "Mode Hop" label, there is a discontinuity in λ, and the laser begins lasing in a new dominant mode, but at the same wavelength that began the previous cycle. The distance in λ between the bottom and the top of the ramp is the free spectral range of the grating. Thus, it can be seen that Verdiell discloses mode hopping, <u>not the simultaneous emission of a few modes</u>.

<u>Regarding the Examiner's first reference to Verdiell (paper No. 12, page 3):</u>

The Examiner cites Verdiell at col. 4, lines 23-54 as disclosing multimode output of at least two modes within the grating. This reference is believed to be incorrect. The Examiner is apparently referring to Verdiell's reference, "which is generally a single mode fiber, but depending upon the application, may also be a multimode fiber". (Verdiell, col. 4, lines 24-27).

Verdiell's laser launches light into an output fiber 20 (see fig. 1). Whether that fiber is capable of supporting single modes or multi modes is an entirely different matter than whether the laser itself is lasing in more than one mode. *It is not the transmission fiber that determines how many modes are present within the laser cavity.* What makes that determination is the gain curve of the lasing

medium, the optical path length of the cavity, the response curve of the grating, and the reflectance curve of the cavity end-reflector.

In Verdiell the laser is always lasing in a single longitudinal mode and therefore at a single wavelength (single line emission). Whether or not a fiber can accept and propagate single mode or multimode light launched into it, is an entirely different matter than the nature of the light sourced by the launching laser. Therefore this citation does not disclose a laser configured to provide multimode output of at least two modes within the grating.

The Examiner further cites to this section in the Response to Arguments at page 4 of paper 12. The Examiner states that "Verdiell et al. does teach providing a multimode output, depending on the intended use/application of the device, see col. 4, lines 23-28). This statement is believed to be incorrect.

Verdiell teaches that a single line emission can be launched into single mode fiber or a multimode fiber, nothing more. This section does not anticipate multimode output of at least two modes. This is because Verdiell does not disclose anything but a single mode output that can adversely change modes by mode hop. Mode hop does not disclose multimode output, but rather the successive single mode emissions at varying wavelength, one mode at a time.

By contrast, the instant invention is not concerned with launching light in a few modes, one mode at time. An important aspect of the invention is the *simultaneous output of a few modes* by an optical communications laser into a single mode or multimode optical fiber (single mode fibers can simultaneously support a few closely spaced modes).

Regarding the Examiner's second reference to Verdiell (paper No. 12, page 4):

The Examiner states that Verdiell also teaches multimode emission at col. 5, lines 39-40. Verdiell's reference here is further discussion of mode hop, which is one mode at a time, not the deliberate simultaneous emission at several modes. The line in Verdiell must be read in the context of the preceding and following lines:

> This fiber DBR source reportedly maintained single frequency operation over the temperature range of 15° C. to 45° C *except there [were] still regions of mode hopping*. Furthermore, current pumping of the gain element in excess of 95 mA caused multimode operation. *It was recognized that laser mode hops cannot be avoided* over such a temperature operating range without some kind of temperature control. (Verdiell, col. 5, lines 36-43).

It can be seen that Verdiell has defined multimode operation as the successive change in wavelength leading to discontinuous mode transitions. Applicants, by contrast, use the term multimode operation in the context of the simultaneous emission of two or more modes. The Examiner states that Verdiell teaches multimode operation, but the opposite is true. Without exception, Verdiell teaches away from the simultaneous emission of two or more modes throughout the Verdiell patent. The instant rejection however, is for anticipation, not obviousness, and Verdiell is wholly devoid of disclosure regarding the simultaneous emission of two or more modes. Therefore Verdiell does not anticipate the invention.

All rejections are traversed and it is believe that the application fully complies with all provisions of 35 U.S.C. §112 and 35 U.S.C. §102(b). It is therefore respectfully suggested that the application should be allowed.

Respectfully submitted,

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